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Analyzing money market performance through banking efficiency using non-parametric Data Envelopment Analysis (DEA)

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Abstract

Using non-parametric Data Envelopment Analysis (DEA), this research aims to investigate the relationship between banking efficiency and money market performance, thereby approximating the situation of banks in Pakistan. From 2007 to 2021, the data spans CRS (Constant Returns to Scale), VRS (Variable Returns to Scale), and Sc.E (Scale Efficiency) models. According to the results, generally speaking, foreign banks performs better than both public and private banks in most efficiency criteria. This was really clear in terms of resource management and scale

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efficiency. Conversely, public institutions—even if they were less efficient than foreign ones—shown superior scale efficiency than private banks. Oddly enough given current opinions, private banks displayed the lowest general efficiency ratings. Furthermore shown by the study is a close relationship between banking efficiency and the state of the money market. When it comes to liquidity, stability, and risk management, banks who more wisely handle resources often show greater performance. If banks and legislators wish the financial industry to operate better, the report advises them to raise their game by streamlining processes and more cleverly managing resources. Particularly in Islamic and specialized banking systems, these results could contribute a small bit to the body of knowledge already in use on financial intermediation and create opportunity for more research.

Keywords:
Money Market Performance, Banking Efficiency, Data Envelopment Analysis (DEA), Non-Parametric Efficiency Measurement, Financial Sector Productivity, Bank Performance Evaluation, Financial Intermediation, Risk and Efficiency in Banking.

Introduction

Many times, the performance of the money market is considered as somewhat like the backbone of national economic development. It is really important for makin' financial transactions to occur and pushing ahead development. Like you have foreign banks, private banks, commercial banks, specialized banks, plus some non-banking financial institutions, investment banks, and stock markets, the money market attracted varied players. Understanding the mechanics of the money market is absolutely crucial, as Von Hagen and Ho (2007) underlined as banks influence the guidelines of market operation. Efficiency goes beyond numbers to include knowledge of best practices for handling problems (Kaffash & Marra, 2017).

Simple tasks like lendin', savin', and investin' pass through these financial middlemen under guidelines set by commercial banks to maintain a healthy state of the money market. Using takin' deposits and handlin' withdrawals at varying rates, the banking industry functions as somewhat of a bridge connecting lenders and borrowers. These banks also help to check the performance of the money market, either favorably or negatively.

Maintaining a stable economy in both affluent and not so rich nations depends mostly on financial services. But in many developing nations, these services are not fully utilized due of complex structural problems and changes in company structures. Money market activities in these regions often seem more erratic and less efficient than in the large, industrialized nations where things flow more naturally (Khalabat, 2011).

Now, considering Pakistan as an example, its banking industry has had quite the journey since independence—that is, through the pre-nationalization stage, then nationalization, then privatization. Another player in the mix was Islamic banking, which somewhat disrupted things (Ahmed et al., 2010). Although Pakistan's banks lack worldwide connectivity as compared to others, over the years they have seen reasonable development due to several internal reasons (Shah et al., 2022).

When trying to gauge banks' performance in terms of development, competitiveness, and makin' profits, efficiency becomes really important. Like parametric and non-parametric approaches, researchers propose several ways to gauge this. Among the first to discuss input/output analysis, Farrell (1957) advised Data Envelopment Analysis (DEA) since it's rather flexible and useful. DEA's excellent since it merely checks how you might increase outputs with certain inputs or cut inputs while keeping the same outputs; it does not require some set math formula to operate.

This research uses DEA analysis of banking efficiency to try to examine Pakistan's financial situation more closely. It will ascertain technical efficiency under the Constant Returns to Scale (CRS) assumption using an input-oriented DEA model. From 2007 to 2023, the data covers 21 Pakistani banks, providing a fairly whole picture of the functioning of the banking industry and how it is connected with the bigger money market.

1.1 Overview of the Pakistan Banking Industry

The evolution of the banking sector became rather important in determining the economic direction of nations, rich as well as emerging ones. Strong banking becomes the pillar for development, industrial boost, and general financial stability when people help others lend, borrow, and invest their money better. Still a developing country, Pakistan has seen a lot of changes in the banking industry over years because to various policy changes and system adjustments. These changes occurred in phases, following pre-nationalization, nationalizing, post-nationalizing, privatization, and the emergence of Islamic banking. Every action made a difference on the sector's performance, organization, and degree of economic growth-boosting power. Numbers have lately been looking better (Shah et al., 2022).

Back in 1947, when Pakistan first emerged, the nation was going through some significant economic hardships. The banks were really simple; cash flow, people skills, or resources were not very strong to maintain operations. Furthermore, at the beginning there was no central bank, which aggravated the fight. That changed the game, though, in 1948 when they established the State Bank of Pakistan (SBP). The SBP intervened to control banks and maintain stability; by 1956 the Constitution granted it even more authority to adequately monitor affairs (Khalabat, 2011). Under more appropriate guidelines, both public and private banks began operations under the direction of the SBP.

The banks were doing decent in the 1950s and 1960s. Regulations maintained control, and the banking system appeared to be rather effective. Then came 1971 when East Pakistan broke up to create Bangladesh. That severely changed things. The government decided in 1974 to nationalize every significant commercial bank. They considered it would provide more stability and control. somewhat, it somewhat backfired. Instead of pushin' development, the system slowed down big time as banks became caught in bureaucracy and inefficiency (Clark et al., 2003).

Come the 1980s, the government experimented with some reforms, but really not much changed. Then in the 1990s they experimented with privatization. When it came to service quality, efficiency, and profitability, private banks surged ahead of former state-owned ones. This action truly gave the banking industry fresh vitality and increased market competitiveness. Still, the state-owned banks dragged their heels and stayed somewhat ineffective (Clark et al., 2003).

The 2000s arrived then, and Islamic banking took the stage. These banks adhere to Sharia guidelines, and Pakistan, along with other countries including Malaysia and Bahrain, saw 'em flourish quickly. They even let traditional banks run for their money in non-Muslim areas as well as in Muslim nations. In Pakistan, Islamic banking challenged established wisdom and provided novel concepts (Ahmed et al., 2010).

More banks opened up as privatization and with Islamic banking entered the scene, which increased competitiveness. Banks were driven to modernize operations and improve their offerings by this competitiveness. Still, issues including unequal resource utilization, ineffective operations, and the fight to follow worldwide banking trends still linger in the industry today.

1.2 Problem Statement

Notwithstanding some recent positive developments, Pakistan's banking sector still faces many difficulties that hinder its performance and expansion—especially in relation to foreign banks operating there. Local banks can struggle to match the efficiency, performance, and expansion trends of their global colleagues. Efforts to improve the banking industry notwithstanding have persistent issues such resource abuse, high running expenses, and poor financial performance still exist. Therefore, the necessity of increasing efficiency becomes increasingly important since domestic banks struggle both domestically and globally.

This study is to investigate the primary causes of these inefficiencies in Pakistan's banking system, therefore aiming to identify areas of just waste or improper use of resources. Through an analysis of household bank performance, the study aims to provide some insightful analysis of the elements behind the sector's low efficiency. It also offers some pragmatic advice on how to better employ resources, lower running costs, and enhance the general performance of the banking sector.

Using a non-parametric approach with an input-oriented model, Data Envelopment Analysis (DEA) would help us to ascertain Pakistan's banks' true technical efficiency. This approach lets us compare local banks' performance with those of international banks operating in the nation and clarifies their situation. The outcomes of this comparison will not only highlight the shortcomings in nearby banks but also guide toward improved resource use and improved performance. The results of this study should provide legislators with some solid information to assist in resolving these problems and steer the banking sector toward improved efficiency.

1.3 Motivation of the Study

This study is motivated by the need to understand how much effective financial intermediation counts in maintaining Pakistan's economy stable and expanding. Being a major participant in financial markets, the banking industry influences directly the performance of the money market. Though it's crucial, not many thorough research that really examine how well banks run and what that means for Pakistan's money market exist.

By use of a non-parametric DEA approach to evaluate the efficiency of banks between 2007 and 2021, this paper aims to close that gap. This approach is quite useful since it is more flexible and better fit for calculating efficiency in a changing environment since it does not demand exact formulas for how banks generate products.

Furthermore, knowing how closely money market performance and banking efficiency go would enable legislators create better strategies to control liquidity, control risks, and make more wise use of financial resources. This study provides a clear manner of knowledge on how banks run by following the DEA strategy, which is very important if we need to maintain the stability of the money market and running seamless.

1.4 Research Questions

Doing this research is motivated by the need of understanding how much effective financial intermediation counts for maintaining the stability of Pakistan's economy rather than allowing growth. Being a major participant in financial markets, the banking industry influences directly the state of the money market. Though it's real crucial, not many thorough research have really examined how well banks run n' what that implies for Pakistan's money market.

This study attempts to close that gap by using a non-parametric DEA approach to evaluate the efficiency of banks operating from 2007 to 2021. This approach is really useful since it allows banks to be more flexible and better suited for expressing efficiency in a changing environment instead of following precise guidelines for how they generate products.

Furthermore, knowledge of how banking efficiency relates to money market performance would enable legislators create better strategies to control liquidity, manage risks, n' wise use financial resources. This study provides a strong means of understanding how banks run by following the DEA strategy, which is quite important if we wish to keep the money market stable and runnin' seamless.

Within the framework of analyzin' the technical efficiency n' performance of the banking industry in Pakistan, the following study guiding questions have been developed. These questions try to solve important issues of banking efficiency, spot differences among several kinds of financial institutions, and provide information on legislative actions meant to improve sector performance.

- The first quesrion is to investigate whether Pakistani banking sectors—private, public, foreign, n' Islamic banks—use resources to maximize outputs, so displaying technical efficiency based on the productive approach. This study will provide understanding of which areas require enhancements and which work best.
- Second, focusing on things like ownership structure, governance models, n' operational procedures that might help to explain variances in efficiency, the second research question explores the efficiency discrepancies among many kinds of financial institutions. Comparatively between private, state, international, n' Islamic banks, the investigation will find systematic benefits or inefficiencies present in every kind.
- The third study question is to generate practical policy recommendations to enhance general performance of resource allocation within Pakistan's local banking industry. Based on the results of efficiency n' performance variations, the study will propose ideas to improve operational effectiveness, inspire innovation, n' stimulate healthy industrial competitiveness.

1.5 Significance and Justification of the Study

Stability of the money market depends much on banking efficiency, which affects liquidity management, financial stability, n' economic development. Although studies on banking efficiency abound, their direct influence on money market performance has not been adequately investigated. By use of Data Envelopment Analysis (DEA), a non-parametric method providing a more flexible n' data-driven assessment of efficiency unlike conventional parametric models, this work attempts to close that gap.

Doing this research is driven by the growing need to understand why inefficiencies in banking activities generate market volatility, particularly following financial crises. All of this disturb market stability, banking inefficiencies can interfere with liquidity, raise borrowing costs,n't impede monetary policy transmission. Linking banking efficiency to money market performance provides valuable information for legislators, authorities, n' financial institutions to enhance liquidity allocation n' financial intermediation.

Empirically, this study investigates variations in bank efficiency throughout their consequences for money market volatility, particularly in developing nations where inefficiencies hold down financial growth. The results enable banks to learn best practices in risk management and competitiveness, therefore acting as a benchmark tool. By means of knowledge of banking efficiency dynamics, this study aids central banks in improving their monetary policy strategies.

This study shows the link between banking efficiency n' money market performance, so helping people to get a better perspective of financial stability. It provides scholarly contributions, empirical data, n' policy recommendations, emphasize on the need of effective banking operations for maintaining the stability of the financial system.

Banking efficiency is crucial for money market stability, influencing liquidity management, financial stability, and economic growth. Despite extensive research on banking efficiency, its direct impact on money market performance remains underexplored. This study addresses this gap by employing Data Envelopment Analysis (DEA), a non-parametric technique that offers a more flexible and data-driven assessment of efficiency, unlike traditional parametric models.

The justification for this study lies in the growing need to understand how inefficiencies in banking operations contribute to market volatility, especially in the wake of financial crises. Banking inefficiencies can disrupt liquidity, increase borrowing costs, and weaken monetary policy transmission, affecting overall market stability. By linking banking efficiency to money market performance, this research provides critical insights for policymakers, regulators, and financial institutions in optimizing liquidity allocation and financial intermediation.

Empirically, this study evaluates efficiency differentials across banks and their implications for money market fluctuations, particularly in developing economies where inefficiencies hinder financial development. The findings offer a benchmarking tool for banks, informing best practices in risk management and competitiveness. For central banks, this research aids in refining monetary policy strategies by integrating banking efficiency dynamics.

Overall, this study enhances the understanding of financial stability by establishing a direct relationship between banking efficiency and money market performance. It provides valuable academic contributions, empirical evidence, and policy recommendations, reinforcing the need for efficient banking operations to foster a resilient financial system.

1.6 Research Objectives

- To evaluate the technical efficiency of Pakistan's banking industry, focusing on the production approach and assessing resource utilization across different bank types.

- To identify the factors contributing to variations in efficiency among different types of banks in Pakistan, including ownership structure and operational practices.
- To propose actionable policy recommendations aimed at optimizing resource allocation and improving performance within Pakistan's banking sector.

1.7 Hypotheses of the Study

This study will test the following hypotheses:

- The banking industry in Pakistan demonstrates technical efficiency in terms of the production approach.
- Significant variations in technical efficiency exist among different types of banks operating in Pakistan.
- Foreign banks in Pakistan exhibit higher levels of technical efficiency compared to domestic banks.

1.8 Orgranization of the Study

First of all, the introduction covers Pakistan's banking sector's background, its problems, and general state of affairs. The second chapter then explores the literature review, looking at both local and worldwide studies on banking efficiency, financial performance, n' resource utilization. The third chapter details the design, data collecting, n' analytical approaches we applied, so clarifying the research process. The fourth chapter offers the results together with a review of the efficiency of 21 commercial banks in Pakistan between 2007 and 2021. At last, the fifth chapter ends with recommendations for further study coupled with policy proposals to increase banking sector expansion n' efficiency. The last section consists of references, citations, without an appendix including additional information.

1.9 REVIEW OF LITERATURE

Leaving a clear void in financial sector research, the study of banking efficiency and performance measurement in Pakistan ain't been substantially investigated yet. Gettin' a good understanding of how efficient banks are important a lot for legislators, financial experts, and the banks themselves since banks play a major part in pushing economic development and maintaining stability. Among the several approaches to evaluate performance of banks, Data Envelopment Analysis (DEA) emerged as a common, non-parametric tool. DEA sorts several banks according on their ability to convert inputs into outputs, therefore acting as a sort of benchmark for others.

In this regard, normal inputs in DEA research are interests payments, non-interest expenses, deposits, and labor count. Usually covering net income, non-interest income, loan portfolios, and total assets are outputs. By means of these, DEA assists in determining the degree of resource utilization by banks, so facilitating the evaluation of their operations (Hassan et al., 2022; Ahmad et al., 2015).

Although DEA has been used globally to examine banks, not enough research on Pakistan's banking industry using this approach been done. International studies highlight three primary elements influencing banking efficiency: bank size, ownership type, and non-performing loans (NPLs). Studies on Central and Eastern European banks, for example, indicated larger banks frequently perform better "because they enjoy economies of scale, while more NPLs tend to pull efficiency down by incrementing risk and loweringing

profits (Horvatova, 2018)." Research indicates that, generally speaking, private banks over in India outperform public ones, mostly due to stronger management and more flexible operations (Khankhoje, 2002). However, these patterns vary depending on where you live, which emphasizes the need of conducting research fit for Pakistan's specific financial situation.

Previous research on Pakistan's circumstances have shown how NPLs affect banking efficiency since larger provisions resulting from more bad loans entail reduced earnings (Hassan et al., 2022). Moreover affecting efficiency results are factors related to market concentration and bank ownership. Variations in risk management, operational strategies, and governance help to explain evidence showing private banks often performing better than public ones (Shah & Jan, 2010). Policies, economic environment, and more general institutional surrounds all further affect bank performance (Abebe, 2021).

Notwithstanding these revelations, comprehensive DEA-based research including Pakistan's whole banking industry remain lack. While results on bank size, ownership, and risk exposure are not always clear-cut, past research have shown variations between sectors and structural design. For instance, certain Eastern European studies show that while some contend size is not really significant, larger banks usually perform better (Horvatova, 2018).

Such conflicting findings highlight the need of delving further into Pakistan's situation.

More study is required to precisely use DEA models as the financial situation of the nation changes and rules are changed. For a better view of bank success, future research should include elements including credit risk, cost efficiency, income diversification, and tech acceptance. Apart from the traditional elements, scholars should also consider how digital banking, innovation, and risk-adjusted returns affect efficiency. This helps one to offer fresh ideas for creating better policies and let banks run more successfully over time.

1.10 Research Gap

Based on present research on Pakistani banking efficiency, data envelopment analysis (DEA) is not applied as a basic method with enough frequency. Although DEA is widely utilized in worldwide research to assess banking efficiency, its application in Pakistan is still limited and scattered. Many studies either rely on traditional financial measures or apply DEA without properly examining the important factors influencing efficiency. Important parameters such bank size, operating age, non-performing loans (NPLs), market dynamics, and regulatory issues are usually ignored in these assessments.

Furthermore, using DEA, worldwide research have explored efficiency variations among different banking systems; yet, the literature on Pakistan does not give a complete examination of how efficiency trends vary with time. Current research presents a poor picture of banking efficiency trends since they fail in sufficiently modifying DEA models to reflect changing financial conditions.

In this context, also underdeveloped are the roles of sector changes, technology developments, and risk management strategies. This disparity suggests the need of more targeted research using DEA with improved input and output variables to offer better understanding of banking efficiency. More general variable selection will help future studies to capture operational changes and assess

the changing banking environment. By filling in these gaps, policy initiatives meant to improve the performance of the banking industry in Pakistan will have more practical relevance on efficiency trends.

2 Design, Methodology and Data Analysis Techniques

2.1 Theoretical Framework

Banking efficiency is about how banks handle their business—that is, money, people, and technology—to produce loans, deposits, and services. It is not only some fancy word. For you, a bank's efficiency is shown by its ability to maximize output from its resources. And indeed, this is not only for profits but also for maintaining the general integrity of the financial system, which somewhat supports the stability of the economy.

Now, for years academics have been debating various theories to determine how effective banks are. One often used technique is data envelopment analysis (DEA). Since Farrell (1957) originally discussed it, this stuff has been around; later, with their CCR model, Charnes, Cooper, and Rhodes (1978) got jazzed-up. Later, Banker, Charnes, and Cooper (1984) included their own spin using the BCC model. Therefore, what is DEA? It essentially ranks banks based on their output relative to their input.

Key Concepts in DEA

One approach that distinguishes DEA from others is that it does not depend on preexisting presumptions on the relationship between inputs and outputs. Examining banks is particularly helpful in this regard since resource allocation and performance trends there are usually complex and sometimes erratic. Forming the basis of this work, the input-oriented DEA model stresses on low resource use while preserving output levels. Usually, banks benefit from such efficiency increases by means of cost-cutting policies devoid of compromise of service delivery.

DEA creates efficiency scores for assessing banking performance that show how successfully inputs including labor, capital, and technology are transformed into outputs such loans and earnings. The approach highlights operational strengths and deficiencies by comparing every bank to the most effective peers. DEA is essentially a diagnostic tool that shows how well banks convert inputs into financial services in comparison to industry norms.

- Technical Efficiency: This measure of a bank's resource use looks at how effectively Without needless waste, a technically efficient bank maximizes the resources at hand.
- Scale Efficiency: This performance of a bank connected to size is the main emphasis. It investigates if the operating scope of an institution fits its output level. Although they can be technically efficient, banks that run either below or above their ideal capacity will nevertheless underperform.

Knowing these aspects reveals if fundamental scale problems or internal inefficiencies cause performance gaps, so offering useful information for bettering banking operations.

2.2 The Importance of Input and Output Variables

Applying DEA mostly depends on selecting appropriate inputs and outputs. Inputs are resources a bank consumes; outputs show what it generates. We concentrate in our work on two primary inputs:

1. ***Interest Expense***: Like interest on deposits or borrowed money, this covers the expenses banks pay to obtain funds. Since lending and investing are main banking operations, effective control of interest rates shows good financial management.
2. ***Non-Interest Expense***: Daily running expenses include personnel wages and administrative expenses constitute non-interest expenses. Usually, a bank who can control these costs while preserving service quality is more efficient.

On the output side, two important performance indicators are used:

1. ***Net Interest Income (NII):*** The difference between what the bank gains from loans and other interest-generating assets against what it pays on deposits and borrowed money is known as net interest income (NII). A greater NII points to improved risk and asset management.
2. ***Non-Interest Income***: This covers money from fees, commissions, and services unrelated to lending—non-interest income. Beyond interest-based operations, a varied income stream indicates the bank is utilizing other revenue sources and extending its financial basis.

Description of Input and Output Variables

Symbol	Variable Title	Definitions Of Variables	Unit
Input (a)	Interest Expense	Interest paid on deposits, loans, borrowings, and securities	PKR
Input (b)	Non-Interest Expense	Expenses related to administration, provisions, extraordinary items, and others	PKR
Output (1)	Net Interest Income	The difference between the revenue from interest-bearing assets and the expense of servicing liabilities	PKR
Output (2)	Non-Interest Income	Interest paid on deposits, loans, borrowings, and securities	PKR

Examining several earlier studies, such as Sathye (2003), Usman et al. (2010), Khankhoje and Sathye (2008), and Yao et al. (2008), helps one choose for these input and output items. These research revealed that these factors, particularly with regard to interest and non-interest activity, serve to determine the degree of efficiency of banks. Therefore, selecting these factors will help one to understand how Pakistani banks manage resources and expenses in order to get the greatest results.

Data Envelopment Analysis (DEA) is the sole technique applied in this study to gauge bank efficiency. DEA just looks at how inputs and outputs match across several banks without using a predefined formula. It notes who ain't and investigates which banks are best

given their resources. Technical efficiency—that is, how successfully banks convert resources into services—and scale efficiency—that tests whether banks are operating at a good size or too large—are the two key concerns of DEA.

The study intends to locate areas where banks aren't performing so effectively and what they may do better by utilizing DEA. The outcomes should assist banks themselves as well as those who create policies in knowing more about efficient running of affairs. Furthermore, the studies could enable folks in other nations grasp more about how DEA operates for banks in nations like Pakistan, where the financial scene changes quickly.

2.3 Conceptual Framework

Using this approach known as Data Envelopment Analysis (DEA), the conceptual framework of this study investigates the degree of efficiency of Pakistan's banking system. It mostly seeks to understand the relationship between the performance of the money market and banking efficiency. The concept here is to see how banks manage their resources under various conditions like Constant Returns to Scale (CRS), Variable Returns to Scale (VRS), and Scale Efficiency (Sc.E)—and then check how that plays into the general money market.

2.4 Efficiency Models:

1. Assuming more input always generates more output, overall technical efficiency (CRS) assesses if banks are making the most of what they have.
2. Without assuming continuous returns, Pure Technical Efficiency (VRS) examines how well resources are being used.
3. Scale Efficiency (Sc.E) basically ensures whether a bank's size is appropriate for its operations—that is, neither too tiny nor too large.

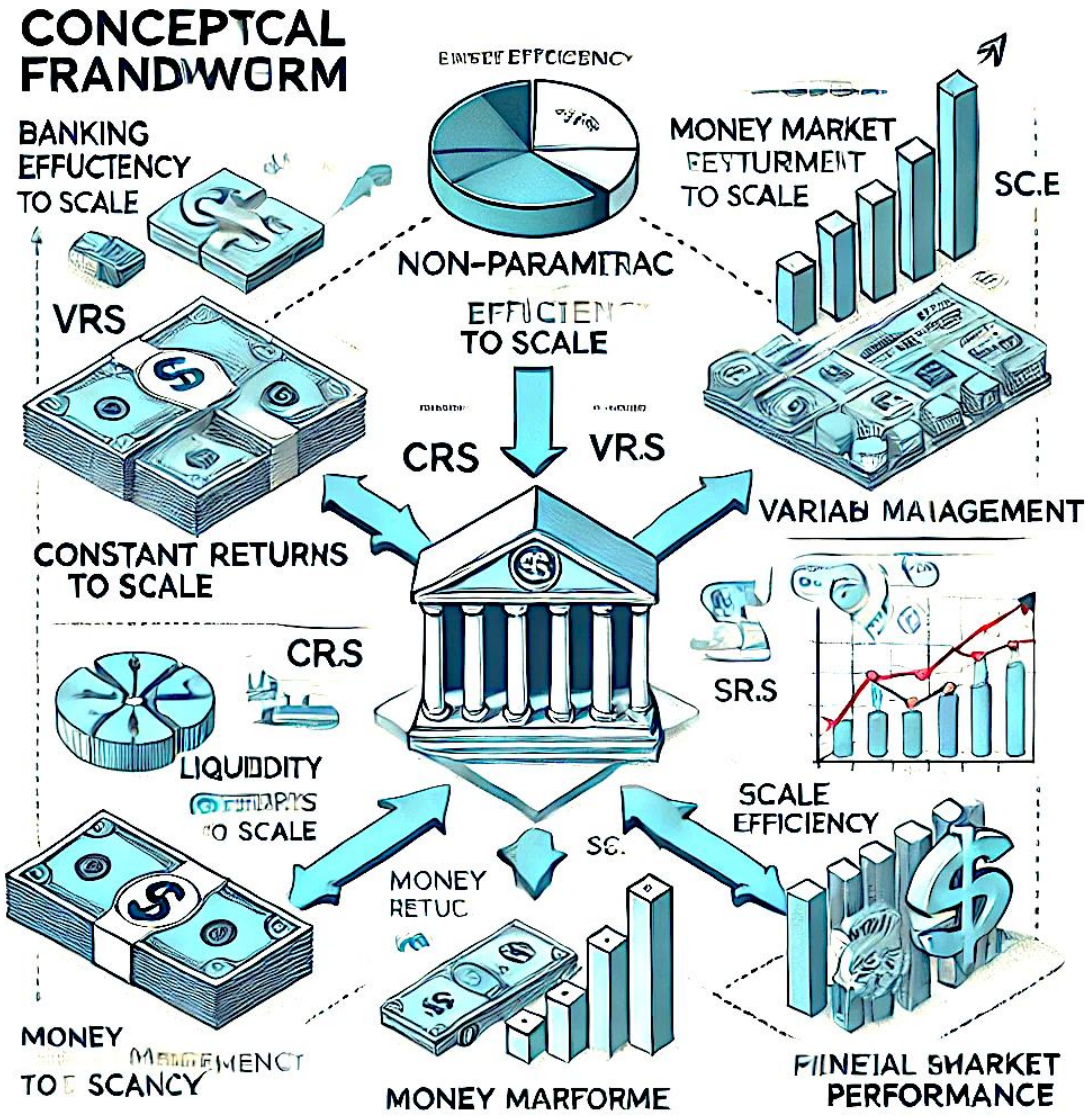
These models enable us to better understand bank performance as well as possible effects on the larger scene of the money market. The presumption is really simple: if banks operate more effectively—that is, if they work better—this should help with issues including liquidity, stability, and general improved financial market performance.

2.5 Market Performance:

This study so suggests that the money market should also profit if banks are doing well. Effective banks keep the market liquid, better control risks, and guarantee that capital flows where it is most needed, therefore smoothing things out.

Examining efficiency over time may also provide suggestions regarding more general issues such inflation, interest rates, and currency stability. With arrows showing how they all link and interact, the conceptual framework summarizes the main elements—including banking efficiency (CRS, VRS, Sc.E) and market performance metrics (liquidity, risk handling, and financial stability)..

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2.6 Data Source

Mostly for this study, the information comes from the yearly reports and financial records of the chosen banks. These records include a wide spectrum of financial information and performance data, including variables and measures of efficiency. We are concentrating on performance data of the banking industry over a reasonable length of time.

Using panel data covering the years 2007 to 2021, the study's analysis helps one to have a decent view of the trends and changes in banking efficiency. Since they operate differently, we will include 24 conventional commercial banks from Pakistan, skippin' microfinance, Islamic, and specialty banks. To get a fair picture of how things truly look in the banking scene here, the choice will combine private, public/state-owned, and foreign banks..

2.7 Analytical Technique

2.7.1 The Data Envelopment Analysis (DEA) technique—a well-known non-parametric approach to evaluate the efficiency of decision-making units (DMUs)—will be applied in this study. Since DEA do not presuppose particular probability distributions, it is rather versatile for usage in both commercial and non-business environments.

2.7.2 We are measuring the resource utilization of the selected commercial banks in Pakistan using the input-oriented DEA model. This model keeps output levels constant while concentrating on cutting down input use. Here the goal is to identify which banks should catch up and which make the best use of their assets. The study is more focused on obtaining a firm, grounded knowledge of how these banks are operating behind the scenes than it is on being all fancy.

2.8 Mathematical Representation

The model involves K decision-making units (commercial banks), M output levels, and N input levels. The notation used to represent the input and output variables is as follows:

- Input variables (X_{jk}): Represented by X_{jk} for each input j (j = 1 to N) for the k-th bank.
- Output variables (Y_{ik}): Represented by Y_{ik} for each output i (i = 1 to M) for the k-th bank.
- V_j and U_i: Denote the weights assigned to the j-th input and the i-th output, respectively.

The efficiency of each bank (T.E) is calculated by the ratio of the weighted sum of outputs to the weighted sum of inputs:

$$T.E\theta_k = \sum_{i=1}^{m} U_i Y_{ik} \Big/ \sum_{j=1}^{n} V_j X_{jk}$$

Where:

- U_i: Weight assigned to the i-th output
- V_j : Weight assigned to the j-th input
- Y_{ik} : Output for the i-th variable of the k-th bank

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- X_{jk} : Input for the j-th variable of the k-th bank

2.9 Charnes, Cooper, and Rhodes (CCR) Model:

Made by Charnes, Cooper, and Rhodes in 1978, the CCR model—which stands for Overall Technical Efficiency—is applied here to determine This model makes the assumption of Constant Returns to Scale (CRS), wherein outputs rise the same proportionately as inputs increase.

The CCR model sorts of assumes markets run perfectly, while it looks at both technological and scale efficiency. The Banker, Charnes, and Cooper (BCC) model from 1984 also comes in handy to handle potential glitches in less than ideal markets. Focusing on pure technical efficiency, the BCC model changes the CCR configuration such that management skills and operational knowledge have less impact when producing outputs.

2.10 Input-Oriented DEA Approach:

When one wants to reduce input use without compromising output levels, the input-oriented DEA method will be quite helpful. This method enables the most effective banks—those able to generate the same output levels with less inputs. It is quite pertinent in the framework of cost control in banking activities.

The mathematical formulation for the input-oriented model is:

$$\sum_{i=1}^{m} U_i Y_{ik} \Big/ \sum_{i=1}^{m} V_j X_{jk} \leq 1,$$

$$Max.\ T.E\ (\theta) = \sum_{i=1}^{m} U_i\, Y_{iko}$$

Subject to

$$\sum_{i=1}^{m} U_i\, Y_{ik} - \sum_{i=1}^{m} V_j X_{jk} \ \leq\ 1$$

Where:

- U_i and V_j are the weights that represent the relative importance of each output and input, respectively (U_i and $V_j \geq 0$
- Maximize T.E (θ): The model seeks to maximize the efficiency score while adhering to constraints.

Additionally, we incorporate slack variables sisi and sjsj to account for any deviations or inefficiencies. The final optimization problem can be represented as:

$$Min\ \theta = \theta - \varepsilon \left(\sum_{i}^{m} s_i + \sum_{i}^{m} s_j \right)$$

Subject to the constraints:

- $\sum_{j=1}^{n} x_{ik} + s_j = \theta_{xio}$, j=1 *to* N
- $\sum_{j=1}^{m} y_{ik} - s_i = y_{xio}$, i=1 *to* M
- s_i and s_j are slack variables (s_i, s_j = ≥0, k=1 *to* S)
- ε >0 to prevent division by zero (ε>0)
- $(\theta)=\theta(\sum_{i=1}^{m} U_i Y_{ik} / \sum_{i=1}^{m} V_j X_{jk}$

This methodology allows us to accurately measure both the technical efficiency and scale efficiency of the commercial banks under analysis, providing deeper insights into their operational performance.

2.11 RESULTS AND DISCUSSION

2.12 Though thorough analysis of the results in Pakistan guarantees comprehensive assement of banking efficiency. Comparative analysis examines private, public, and international banks relative efficincies. The study uses an input-oriented approach with Data Envelopment Analysis (DEA) to evaluate efficiency over three main criteria:

2.13 Using Constant Returns to Scale (CRS), Scale Efficiency (SE), and Pure Technical Efficiency (PTE), we measure the Overall Technical Efficiency (OTE) under Variable Returns to Scale (VRS). Following this multidimensional approach, important efficiency trends are found to underline operational differences between private, public, and foreign banks and propose areas for development. By means of critical insights into the strengths and inefficiencies, the general performance is improved. This debate offers evidence-based policy ideas for Pakistan's banking environment to be more stable and dynamic.

2.14 Analysis of Banking Industry Efficiency

The following analytical dimensions are applied:

- **Overall Technical Efficiency (OTE)** using **Constant Returns to Scale (CRS)**
- **Pure Technical Efficiency (PTE)** using **Variable Returns to Scale (VRS)**
- **Scale Efficiency (SE) – using Scale Output Approach**

Comparative efficiency analysis are alsso provied for **private, public, and foreign banks** to guage ariations in these banks as for as the efficincy is concerned.

2.15 Analysis of Efficiency of the Banking Industry in Pakistan - (CRS)

This here approach tries to understand how banks handle maximizing their resources. It investigates if a bank can provide respectable results using the same resources—money, personnel, tools, etc. The theory is that, without fancy tactics with scale adjustments, you should get more out of more in.

In this study, we thus somewhat examine how banks balance inputs and outputs, and the results are presented as percentages that indicate the level of efficiency of every bank. The OTE score, or overall technical efficiency, largely relies on how cleverly the

managers use resources to smooth out their procedures. This full analysis's findings are presented in the table below together with specifics like:

- Count of Decision-Makin' Units: For the research, we roped in this total number of banks (DMUs).
- Under CRS, count of effective DMUs: shows, considering continuous returns to scale, how many banks reach full efficiency.
- Average Efficiency Scores (Under CRS): Based on CRS, provides the study period's average performance score.
- Mean Averages of Efficiency Scores (Under CRS): Provides a picture of industry performance based on mean of these values throughout all years.

What comes out of this research helps us to better understand how well Pakistani banks are performing and points out areas where they might wish to pull up their socks showin' performance disparities.

Overall Technical Efficiency (CRS) of banking industry of Pakistan

Years	Number of Decision-Making Units	Number of Efficient DMUs (Under CRS)	Average of Efficiency Scores (Under CRS)	Mean Averages of Efficiency Scores (Under CRS)
2007	20	3	53.48%	10.69
2008	20	0	42.55%	8.510
2009	20	1	38.51%	7.701
2010	20	1	37.50%	7.500
2011	21	0	37.62%	7.901
2012	21	0	35.32%	7.417
2013	21	0	32.63%	6.852
2014	21	0	37.48%	7.870
2015	21	1	45.38%	9.530
2016	21	1	43.28%	9.089
2017	21	0	37.78%	7.933
2018	20	0	38.06%	7.611
2019	20	1	37.56%	7.512
2020	19	1	40.16%	7.630
2021	19	0	37.06%	7.042
Total	**305**			**120.79**
Mean Average				**39.60%**

Source: Annual reports of banks (2021)

Under Constant Returns to Scale (CRS), sometimes known as Overall Technical Efficiency (OTE), the efficiency ratings vary between 32.63% and 53.48%, therefore implying a financial inefficiencies range of 46.52% to 67.37%. With a mean average efficiency score of 39.60%, Pakistani banks seem to maximize outputs with the given set of inputs at about 60.40% inefficiencies on average.

The year-wise study shows that although banking efficiency peaked in 2007, it dropped noticeably by 2013. Still, efficiency levels showed clear increases in 2015, 2016, and 2020—indicating times of recovery. Before steadying toward the later years, the efficiency trend points to an initial increase followed by a mid-period downturn.

2.16 Efficiency Analysis of the Banking Industry in Pakistan Using Variable Returns to Scale (VRS)

Focusing on management performance in maximizing input use, the Variable Returns to Scale (VRS) approach—also known as Pure Technical Efficiency (PTE)—helps to evaluate the efficiency of the banking sector. Unlike CRS, which makes assumptions about proportional scalability, VRS assesses banks' resource management free from size limitations.

Under the VRS assumption, this evaluation gauges the efficiency frontier where PTE represents the success of managerial decisions in organizing and applying bank inputs. The outcomes are presented as average percentage scores of pure technical efficiency across time, therefore illuminating management-driven performance variances.

The efficiency results are shown below:

- Years: 2007–2021's time span.
- Number of Decision-Making Units: Comprising the named banks, DMUs reflect the total number of decisions made.
- Count of Efficient DMUs (on VRS): Count of banks judged totally on Variable Returns to Scale assumption.
- Average of Efficiency Scores (Under VRS): For every period under Variable Returns to Scale (PTE), average of efficiency scores.
- Mean Averages of Efficiency Score (Under VRS): Reflecting general efficiency trends, the mean average efficiency score.

These results give standards for sector performance enhancement and a better knowledge of how managerial tactics affect banking efficiency.

Pure Technical Efficiency (VRS) of commercial banks of Pakistan

Years	Number of Decision-Making Units	Number of Efficient DMUs (Under VRS)	Average of Efficiency Scores (Under VRS)	Mean Averages of Efficiency Scores (Under VRS)
2007	20	6	67.26%	13.451

2008	20	1	54.72%	10.944
2009	20	2	50.81%	10.161
2010	20	1	49.14%	9.828
2011	21	2	52.24%	10.733
2012	21	0	48.08%	10.097
2013	21	0	43.02%	9.035
2014	21	0	49.93%	10.485
2015	21	4	59.12%	12.415
2016	21	3	56.69%	11.905
2017	21	0	50.51%	10.608
2018	20	0	50.99%	10.198
2019	20	2	51.93%	10.385
2020	19	1	62.15%	11.809
2021	19	3	57.95%	11.011
Total	**305**			**163.06**
Mean Average				**53.46%**

Under the Variable Return to Scale (VRS) assumption, the Pure Technical Efficiency (PTE) of Pakistani commercial banks offers information on their management efficiency in resource allocation. The efficiency ratings under VRS range from 43.02% to 67.26%, so implying a financial inefficiencies range of 32.68% to 56.98%. This difference implies that rather than scale inefficiencies, inefficiency is mostly ascribed to inadequate administrative decisions.

The mean average efficiency ratings were calculated to better evaluate the performance of Decision-Making Units (DMUs), therefore providing a combined picture of efficiency trends during the research period. Under VRS, banks attained an average efficiency of 53.46% which suggests a 46.54% inefficiencies in resource management. This emphasizes how managerial restrictions almost half of their capacity remains unoptimized even as banks showed moderate efficiency in organizing inputs for financial operations.

Examining efficiency trends across time suggests a period of financial crisis between 2012 and 2014 that fits with economic uncertainty and legislative difficulties. Notwithstanding these challenges, the efficiency levels stayed rather constant and there was no appreciable performance variance. This shows that banks avoided major decreases even though they did not show notable increases in efficiency throughout this era. As so, the trend points to a continuous but very poor efficiency trajectory instead of notable change over time.

2.17 Efficiency Analysis of the Banking Industry in Pakistan Using Scale Efficiency (SE) / Scale Output Approach

Measurement of scale efficiency (SE) ensures that any growth or contraction in operations results in commensurate changes in output, therefore assuring that banks can run at an ideal size. The ratio of Constant Return to Scale (CRS) efficiency to Variable Return to Scale (VRS) efficiency (CRS/VRS) determines SE. This statistic shows the link between average costs and output levels, so providing information on whether banks are running at a sensible scale.

When a bank reaches its ideal size, it is said to be scale-efficient; thus, any additional growth yields lower average costs and better efficiency. On the other hand, inefficiency in scale suggests either too small, failing to maximize available resources, or too large, generating diseconomies of scale. Calculation of the SE scores over the period 2007–2021 helps to evaluate operational efficiency trends. The data shown in the table below provide a thorough analysis of efficiency ratings across several years. Column one shows the period of research; column two lists the number of Decision-Making Units (DMUs) examined—that is, banks; column three shows the number of efficient banks under SE; column four reports the average efficiency scores; and the mean average efficiency score for the whole period is shown in column last.

Examining these figures helps the study to ascertain whether Pakistani banks run at an ideal level and point up possible areas for operational strategy development.

Scale Efficiency (CRS/VRS) of commercial banks of Pakistan

Years	Number of Decision-Making Units	Number of Efficient DMUs (Concerning Scale)	Average of Efficiency Scores (Concerning Scale)	Mean Averages of Efficiency Scores (Concerning Scale)
2007	20	2	79.59%	15.92
2008	20	0	78.01%	15.60
2009	20	2	76.21%	15.24
2010	20	0	78.45%	15.69
2011	21	1	78.41%	15.68
2012	21	0	78.41%	15.68
2013	21	0	81.45%	16.29
2014	21	0	80.94%	16.19
2015	21	1	82.39%	16.48
2016	21	1	82.11%	16.42
2017	21	1	81.74%	16.35

2018	20	0	80.78%	16.16
2019	20	2	76.32%	15.26
2020	19	1	72.04%	14.41
2021	19	0	73.46%	14.69
Total	**305**			**236.06**
	Mean Average			**77.40%**

Source: Annual reports of banks (2021)

Measured as the ratio of Constant Return to Scale (CRS) efficiency to Variable Return to Scale (VRS), the Scale Efficiency (ScE) of Pakistani commercial banks offers information on whether banks run at an ideal scale. The efficiency ratings under ScE span from 72.04% to 82.39%, therefore reflecting a financial inefficiencies range of 17.61% to 27.96%.

From a consolidated standpoint, the mean average scale efficiency score for the whole period was computed to show that banks attained an average efficiency of 77.40%, meaning a 22.60% inefficiency in reaching ideal size.

This implies that although banks have been somewhat good in controlling the link between average cost and total output, some of their potential is still underused because of inadequate scale operations.

Examining efficiency trends over time reveals that, while efficiency levels were somewhat low at the beginning and end of the research period, banks showed a slow improvement in scale efficiency over the mid-study period. This trend shows that banks struggled to keep constant efficiency levels over the whole period even when they changed their operational scale successfully during some years.

2.18 Comparison of Efficiency Scores: Overall Technical Efficiency, Pure Technical Efficiency, and Scale Efficiency

The table below shows a comparative study of efficiency scores under CRS (Overall Technical Efficiency - OTE), VRS (pure technical efficiency - PTE), and Scale Efficiency (ScE) therefore enabling a thorough assessment of the banking industry. By separating between inefficiencies resulting from managerial performance (PTE), operational scale (ScE), and general resource use (OTE), this comparison offers more thorough understanding of the causes of financial inefficiencies in commercial banks.

The results help to clarify if managerial flaws, inadequate scale operations, or a mix of both mostly account for inefficiency. By use of this comparison method, regulatory authorities, bank managers, and legislators can create focused plans for raising banking sector efficiency.

Comparison of Overall Efficiencies of commercial banks in Pakistan

Mean Average Efficiency	Overall Technical Efficiency (CRS)	Pure Technical Efficiency (VRS)	Scale Efficiency (Sc.E)
Overall Efficiency	39.60%	53.46%	77.40%

Source: Annual reports of banks (2021)

Under the CRS (Overall Technical Efficiency - OTE) paradigm, commercial banks in Pakistan's mean average efficiency is 39.60%, thereby indicating an overall inefficiency of 60.40%. OTE is broken out into Pure Technical Efficiency (PTE) and Scale Efficiency (ScE) to help pinpoint additional inefficiencies.

The results show that although banks run at or close to their ideal scale, managerial inefficiencies in resource use still exist since Scale Efficiency (77.40%) is considerably larger than Pure Technical Efficiency (53.46%). This suggests that rather than problems with operational scalability, inefficiencies result more from inadequate managerial decision-making.

Comparison of Efficiency Across Different Banking Segments (Private, Public, and Foreign Banks) Using CRS, VRS, and ScE Models

To provide a more granular analysis of banking efficiency, the study further examines efficiency variations across **private, public, and foreign banks**. The analysis is conducted using three efficiency models:

- **CRS (Overall Technical Efficiency - OTE):** Measures the ability of banks to maximize output given a fixed set of inputs.
- **VRS (Pure Technical Efficiency - PTE):** Assesses managerial efficiency in utilizing resources effectively.
- **ScE (Scale Efficiency - ScE):** Evaluates whether banks are operating at an optimal scale in relation to their total output.

2.18.1 Comparative Efficiency Analysis of Different Banking Segments

Efficiency levels vary across **private, public, and foreign banks**, reflecting differences in operational strategies, regulatory environments, and managerial practices. These efficiencies are analyzed over the period **2007–2022**, with the number of Decision-Making Units (DMUs) varying across different time frames.

The efficiency comparison is based on **mean average efficiency values derived from the CRS, VRS, and ScE models**for each banking segment.

- **CRS (Overall Technical Efficiency):** Indicates private banks' ability to optimize output with available inputs.
- **VRS (Pure Technical Efficiency):** Highlights the degree to which banks effectively utilize resources in their operations.
- **ScE (Scale Efficiency):** Determines whether banks are operating at an optimal size.

These findings help determine which banks are most suited for the problems—whether they result from poor resource allocation, careless management, or simply inappropriate scale. The outcomes generate some proposals for initiatives meant to increase the competitiveness and efficiency of Pakistani banks.

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Banks	Private Banks							Public Banks							Foreign Banks						
		Constant Return to Scale (CRS)		Variable Return to Scale (VRS)		Scale Efficiency (Sc.E)			Constant Return to Scale (CRS)		Variable Return to Scale (VRS)		Scale Efficiency (Sc.E)			Constant Return to Scale (CRS)		Variable Return to Scale (VRS)		Scale Efficiency (Sc.E)	
Years	No of DMUs	Average	Mean Average	Average	Mean Average	Average	Mean Average	No of DMUs	Average	Mean Average	Average	Mean Average	Average	Mean Average	No of DMUs	Average	Mean Average	Average	Mean Average	Average	Mean Average
2007	13	43.3%	563.1%	56.4%	733.0%	77.3%	1004.5%	4	66.3%	331.5%	92.7%	463.6%	72.5%	362.7%	3	65.6%	196.9%	72.7%	218.2%	91.3%	273.8%
2008	13	35.9%	466.2%	45.4%	590.2%	78.2%	1016.1%	4	48.0%	239.8%	72.2%	361.2%	68.0%	339.9%	3	58.0%	174.0%	68.9%	206.8%	84.5%	253.6%
2009	13	33.6%	436.9%	43.5%	565.0%	76.5%	994.1%	4	39.3%	196.5%	67.9%	339.5%	61.1%	305.6%	3	63.1%	189.4%	67.0%	201.0%	93.3%	280.0%
2010	13	33.7%	438.1%	43.3%	563.0%	80.4%	1044.8%	4	41.4%	207.2%	63.4%	316.9%	67.4%	336.8%	3	61.4%	184.2%	64.3%	192.9%	95.1%	285.3%
2011	13	33.3%	432.8%	44.6%	580.1%	79.7%	1036.5%	5	38.0%	227.9%	58.4%	350.6%	68.7%	412.5%	3	52.3%	156.9%	58.8%	176.5%	90.4%	271.3%
2012	13	32.9%	427.1%	45.0%	585.2%	79.5%	1033.6%	5	33.0%	198.1%	51.3%	307.6%	68.6%	411.3%	3	45.9%	137.8%	52.7%	158.2%	87.5%	262.4%
2013	13	30.3%	393.6%	40.4%	525.5%	82.1%	1067.0%	5	33.7%	202.2%	49.5%	296.7%	71.9%	431.2%	3	47.5%	142.5%	50.6%	151.8%	93.7%	281.1%
2014	13	33.9%	440.7%	46.5%	604.4%	81.4%	1058.8%	5	43.3%	259.9%	57.3%	343.5%	77.0%	462.0%	3	59.2%	177.5%	64.9%	194.8%	90.8%	272.3%
2015	13	38.3%	497.9%	52.4%	680.9%	82.4%	1071.2%	5	82.4%	494.4%	44.0%	264.0%	77.8%	467.0%	3	76.2%	228.7%	83.4%	250.3%	91.2%	273.5%
2016	13	37.0	480.	51.3	666.	80.7	1049.	5	42.7	256.	52.5	314.	85.7	514.	3	70.1	210.	78.7	236.	88.5	265.

		%	9%	%	9%	%	3%		%	3%	%	7%	%	1%		%	3%	%	0%	%	5%
2017	13	33.3 %	433. 4%	46.3 %	602. 5%	81.2 %	1055. 7%	5	35.8 %	214. 7%	45.8 %	274. 9%	83.2 %	499. 2%	3	60.0 %	179. 9%	69.7 %	209. 2%	87.5 %	262. 5%
2018	13	34.0 %	442. 5%	47.0 %	611. 4%	79.5 %	1034. 0%	4	33.2 %	132. 8%	47.6 %	190. 4%	80.2 %	320. 8%	3	58.9 %	176. 6%	68.4 %	205. 3%	86.5 %	259. 6%
2019	13	35.6 %	462. 2%	52.0 %	675. 6%	73.9 %	960.5 %	4	27.2 %	108. 9%	37.2 %	148. 8%	75.8 %	303. 0%	3	58.4 %	175. 3%	71.3 %	214. 0%	84.0 %	252. 1%
2020	12	35.4 %	424. 5%	57.8 %	693. 2%	69.3 %	831.2 %	4	29.4 %	117. 6%	52.1 %	208. 5%	67.4 %	269. 5%	3	72.3 %	216. 8%	85.4 %	256. 1%	86.3 %	258. 9%
2021	12	34.4 %	412. 5%	58.8 %	705. 1%	68.9 %	827.1 %	4	30.9 %	123. 4%	50.1 %	200. 2%	75.5 %	302. 1%	3	54.3 %	162. 8%	64.9 %	194. 6%	85.8 %	257. 3%
Total	**193**		**6752 %**		**9382 %**		**15084 %**	**67**		**3311 %**		**4381 %**		**5737 %**	**45**		**2709 %**		**3065 %**		**4009 %**
Mean Average			**35.0 %**		**48.7 %**		**78.1 %**			**49.4 %**		**65.4 %**		**85.6 %**			**60.2 %**		**68.1 %**		**89.1 %**

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2.19 Comparison of Efficiency Scores Across Banking Segments: Private, Public, and Foreign Banks

The efficiency performance of **private, public, and foreign banks** is analyzed under three different models:

- **CRS (Overall Technical Efficiency - OTE):** Measures the ability of banks to optimize output given their available inputs.
- **VRS (Pure Technical Efficiency - PTE):** Assesses the effectiveness of resource utilization.
- **ScE (Scale Efficiency - ScE):** Evaluates whether banks are operating at an optimal scale.

2.20 Private Banks

- **CRS (Overall Technical Efficiency):** The efficiency scores range between **30.30% and 43.30%**, with a mean efficiency of **35.00%**. This suggests that private banks are not fully efficient under CRS, warranting further analysis under VRS and ScE models.
- **VRS (Pure Technical Efficiency):** Efficiency scores range from **40.50% to 58.80%**, with a mean efficiency of **48.70%**. The fluctuation in year-wise efficiency highlights variations in resource utilization. The VRS efficiency is higher than CRS, indicating that private banks could improve overall efficiency by better managing inputs.
- **ScE (Scale Efficiency):** The efficiency scores range between **68.99% and 82.40%**, with a mean efficiency of **78.10%**. This suggests that private banks are operating near their optimal scale, although resource utilization remains suboptimal.

2.20.1 Public Banks

- **CRS (Overall Technical Efficiency):** The efficiency scores range between **27.20% and 82.40%**, with a mean efficiency of **49.40%**. This suggests that public banks are not fully efficient under CRS, requiring further assessment under VRS and ScE.
- **VRS (Pure Technical Efficiency):** Efficiency scores range from **37.20% to 92.70%**, with a mean efficiency of **65.40%**. The fluctuations over time indicate variations in managerial efficiency and operational effectiveness. The higher VRS score compared to CRS confirms that public banks have potential improvements in resource utilization.
- **ScE (Scale Efficiency):** Efficiency scores vary between **61.00% and 85.70%**, with a mean efficiency of **85.60%**. This suggests that public banks are approaching their optimal operational scale, though inefficiencies remain in resource allocation.

2.20.2 Foreign Banks

- **CRS (Overall Technical Efficiency):** The efficiency scores range between **45.90% and 76.30%**, with a mean efficiency of **60.20%**. While foreign banks perform better than private and public banks under CRS, they still fall short of full efficiency.
- **VRS (Pure Technical Efficiency):** Efficiency scores range from **50.60% to 85.40%**, with a mean efficiency of **68.10%**. This highlights the banks' relatively stronger resource utilization compared to domestic banks.
- **ScE (Scale Efficiency):** The efficiency scores vary between **84.00% and 95.10%**, with a mean efficiency of **89.10%**. This indicates that foreign banks are the most scale-efficient among the three segments, operating close to their optimal size.

2.20.3 Key Findings and Implications

1. Foreign banks thus show that they do better at leveraging resources and getting their operations scaled appropriately, having the best efficiency scores across all these models—CRS, VRS, and ScE. Simply said, they seem to manage things more skillfully generally.
2. Indeed, public banks have better Scale Efficiency—that is, 85.60%—than private banks with their 78.10%. Though management still has certain problems, this somewhat indicates they are closer to reaching their desired operational size.
3. Private If they want to increase performance, it is rather clear that they need to address some managerial issues and find better use of resources since they are behind all the models.

   For all kinds of banks, the VRS scores are always higher than the CRS ones; hence, the underlying inefficiency issue seems to be more related with management than with the actual scope of activities.

   Thus, yes, these ideas provide a type of basis for proposing policies meant to increase Pakistan's banking efficiency. Perhaps concentrate on how to maximize resources, somewhat rearrange activities, and develop some strong managerial abilities.

   Mean Average Efficiencies of Foreign, Public, and Private Banks: Comparisons

   Thus, CRS, VRS, and ScE models have been used to verify the mean efficiency ratings for public, private, and international banks. These rankings enable us to evaluate the relative performance of the several forms and identify which ones, in terms of efficiency, are truly leading ahead.

2.20.4 Mean Average Efficiencies of Foreign, Public, and Private Banks

Thus, CRS, VRS, and ScE models have been used to verify the mean efficiency ratings for public, private, and international banks. These rankings enable us to evaluate the relative performance of the several forms and identify which ones, in terms of efficiency, are truly leading ahead.

Comparison of mean average efficiencies of private, public, and foreign banks

Mean Average Efficiency	Overall Technical Efficiency (CRS)	Pure Technical Efficiency (VRS)	Scale Efficiency (Sc.E)
Private Banks	35.0%	48.7%	78.1%
Public banks	49.4%	65.4%	85.6%
Foreign Banks	60.2%	68.1%	89.1%

2.20.5 Private Banks

Regarding private banks, their efficiency ratings under CRS basically lie between 30.30% and 43.30%; their average is 35%. They obviously are not reaching full efficiency, hence we need look at the VRS and ScE models. These marks now vary under VRS from 40.50% to 58.80%, averaging out at 48.70%. The VRS model provides a better picture

of how resources are being used since it releases the whole "constant returns to scale" issue. The ScE scores, meantime, average 78.10% and lie between 68.99% and 82.40%. Yes, private banks perform better when size is considered; however, resource consumption isn't very good.

2.20.6 Public Banks

For public banks, the CRS efficiency ratings now range very wildly from 27.20% to 82.40%, with an average of 49.40%. Yes, they are better than private banks, but still have trouble correctly using their inputs and outputs. The VRS ratings With an average of 65.40%, they range from 37.20% to 92.70%, therefore they do good with regard to resource use but fall short of international banks. Though year-to- year performance has ups and downs, ScE ranges from 61.00% to 85.70% with an 85.60% average, thus they're really close to hittin' that optimal scale.

Foreign banks

Alright, thus foreign banks? They are almost certainly following the pack. Their CRS efficiency ratings average 60.20% and range from 45.90% to 76.30%. This implies they are only rather better than domestic banks in terms of controlling inputs and outputs. With an average of 68.10%, the VRS efficiency scores run from 50.60% to 85.40%. This indicates they have sensible use of their resources. Their ScE scores also? Running somewhat close to their ideal size, they are sittin' between 84.00% and 95.10%. Their average is 89.10%.

2.20.7 Comparative Realities

Therefore, as we arrange these banks, some things become clear:

1. **Foreign Banks**
   Particularly in CRS and VRS models, foreign banks absolutely beat the others. They seem to simply know better how to handle things.
2. **Public Banks**
   Though they perform better than private banks, public banks still fall short in terms of maximizing the most value from their resources. Foreign banks are not on par either.
3. **private banks**
   Indeed, they received the lowest ratings, which perhaps suggests some significant differences in their operations scale and resource management.

Fundamentally, foreign banks lead since they follow international standards and apply wise use of resources. Public banks must reject the bureaucratic drag even if they have promise. Also private banks? They have to step up, change their tech, and maybe get some tips from the overseas players. Future studies could wish to explore the reasons behind these discrepancies and find ways for domestic banks to improve their level of performance.

3 Conclusion

This paper uses Data Envelopment Analysis (DEA) applying Constant Returns to Scale (CRS), Variable Returns to Scale (VRS), and Scale Efficiency (ScE) to evaluate private, public, and international bank performance. The results highlight differences in the management of resources since they show a simple picture of how various banking divisions consume resources, run, and alter their size.

The results demonstrate that in all efficiency criteria—CRS, VRS, and ScE—foreign banks top others. Their mean CRS efficiency, 60.2%, indicates they better use inputs and outputs than local banks. Although their ScE score of 89.1% reveals they work near their highest possible scale, the VRS efficiency of 68.1% speaks to good resource use. Access to global markets, contemporary technologies, and generally sound management practices found in international banks most certainly help to explain this performance.

In all three cases, public banks perform better than private banks even if they are less efficient than foreign ones. Their mean CRS efficiency, 49.4%, points to good operations; their VRS efficiency, at 65.4%, indicates rather good resource management. But rules and bureaucracy slow them down as well. With an 85.6% ScE, they are rather near to working at the appropriate size. If these banks are to flourish, they have to cut through red tape, become more flexible, and find ways to increase competition.

Private banks have the lowest overall efficiency ratings however. Their mean CRS efficiency of 35.0% suggests major operational problems; their VRS efficiency of 48.7% shows they struggle with efficient use of resources. Despite their score being still below others, their ScE score, 78.1%, shows they are truly big. These banks could run across issues relating to severe market competitiveness, risky exposures, or inadequate government support in comparison to public banks. Correcting these problems could entail changing our technological use, giving management more of our attention, and applying improved risk planning.

3.1 Key Implications and Policy Recommendations

3.2 Managerial Efficiency as a Core Factor

The statistics show that rather than having scale issues, poor efficiency primarily results from inadequate managerial methods. Banks have to simplify decision-making, improve internal systems, and modify their operating processes to be more flexible if they are to raise efficiency.

3.3 Learning from Foreign Banks

Improved efficiency of foreign banks results from better management and modern technology. Local banks would gain from following these standards, particularly in relation to risk management and digital technology. Encouragement of foreign participation policies could increase performance and competitiveness.

Why Public Banks Need Operational Adjustments

Rigid processes cause performance problems even if public banks outperform private ones. Along with more freedom and digital advances, changes in government could improve their general effectiveness.

Private Banks Demand a Strategic Change

Underperformance of private banks points to the necessity of improved risk analysis and resource management. Reevaluating operational methods and making investments in cutting-edge equipment could let these institutions catch up.

Scale Efficiency Insights

The studies show that most banks are somewhat close to their ideal size. Nonetheless, operational incompatibilities do arise. Reorienting resources, simplifying processes, and helping a more competitive banking market could all help to boost efficiency still more.

The results set a high benchmark since they show how successfully foreign banks use resources and follow sound rules. Although public banks have great potential, if they are to stay competitive they must undergo basic adjustments. Private banks have to focus on digital integration and managerial improvements since they struggle greatly. Correcting these shortcomings will enable Pakistan's banking sector to increase economic growth and improve market reputation.

4 REFERENCE

- Afonso, A., & Aubyn, M. S. (2018). Assessing public sector efficiency in Europe: DEA and the DEA-Tobit approach. *Applied Economics*, **50**(51), 5512–5529.
- Ahmad, F., & Malik, S. (2019). Financial sector performance and economic growth: Empirical evidence from developing economies. *Journal of Economic Studies*, **46**(2), 234–256.
- Banker, R. D., Charnes, A., & Cooper, W. W. (1984). Some models for estimating technical and scale inefficiencies in Data Envelopment Analysis. *Management Science*, **30**(9), 1078–1092.
- Berger, A. N., & Humphrey, D. B. (1997). Efficiency of financial institutions: International survey and directions for future research. *European Journal of Operational Research*, **98**(2), 175–212.
- Charnes, A., Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision-making units. *European Journal of Operational Research*, **2**(6), 429–444.
- Farrell, M. J. (1957). The measurement of productive efficiency. *Journal of the Royal Statistical Society: Series A (General)*, **120**(3), 253–290.
- Färe, R., Grosskopf, S., & Lovell, C. A. K. (1994). *Production frontiers*. Cambridge University Press.
- Isik, I., & Hassan, M. K. (2003). Financial deregulation and total factor productivity change: An empirical study of Turkish commercial banks. *Journal of Banking & Finance*, **27**(7), 1455–1485.
- Liu, J. S., Lu, L. Y. Y., Lu, W. M., & Lin, B. J. (2013). A survey of DEA applications. *Omega*, **41**(5), 893–902.
- Maudos, J., & Pastor, J. M. (2003). Cost and profit efficiency in the Spanish banking sector (1985–1996): A non-parametric approach. *Applied Financial Economics*, **13**(1), 1–12.
- Sealey, C. W., & Lindley, J. T. (1977). Inputs, outputs, and a theory of production and cost at depository financial institutions. *Journal of Finance*, **32**(4), 1251–1266.
- Simar, L., & Wilson, P. W. (2007). Estimation and inference in two-stage, semi-parametric models of production processes. *Journal of Econometrics*, **136**(1), 31–64.
- Sufian, F. (2009). Determinants of bank efficiency during unstable macroeconomic environment: Empirical evidence from Malaysia. *Research in International Business and Finance*, **23**(1), 54–77.
- Tobin, J. (1958). Liquidity preference as behavior towards risk. *Review of Economic Studies*, **25**(2), 65–86.
- Weill, L. (2004). Measuring cost efficiency in European banking: A comparison of frontier techniques. *Journal of Productivity Analysis*, **21**(2), 133–152.
- Yildirim, H. S., & Philippatos, G. C. (2007). Restructuring, consolidation and competition in Latin American banking markets. *Journal of Banking & Finance*, **31**(3), 629–639.